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WARFARE SYSTEM ARCHITECTURE AND ENGINEERING FY 90 SUMMARY REPORT

BY STEPHEN W. PARKER DAVID K. KREIDER CHERYL L. SCHUMAKER
COMBAT SYSTEMS DEPARTMENT

DECEMBER 1990

NAVAL SURFACE WARFARE CENTER
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FOREWORD

On 6 November 1985, the Space and Naval Warfare Systems Command (SPAWAR) was assigned the role of the Battle Force Architect and Engineer by the Secretary of the Navy. In response to this designation, SPAWAR 30 was established as Warfare System Architecture and Engineering (WSA&E) Directorate. The objectives of WSA&E are to assess the overall performance of naval forces, conduct battle force systems engineering, and set the direction for future Navy evolution. The SPAWAR research and development (R&D) centers agreed to provide the technical analysis and systems engineering expertise required to support the WSA&E program.

To implement the WSA&E program, SPAWAR 30 established a multilaboratory architecture working group for each warfare mission area and warfare mission support area. An individual R&D center was designated as the principal technical agent of each working group, responsible to the respective SPAWAR 30 Division Director for the technical integrity of the assessment efforts.

The Naval Surface Warfare Center (NAVSWC) has actively supported the WSA&E program since it began in FY 86. In FY 90, NAVSWC expended $763.6K in direct (SPAWAR 30) funding and contributed an additional 30 workyears in indirect (Center overhead) funding. This report was assembled and edited by the WSA&E Program Office and summarizes NAVSWC's participation in the WSA&E program during FY 90.

Approved by:

STEPHEN W. PARKER, Head
Warfare System Architecture and
Engineering Program Office

CONTENTS

TABLES

LIST OF ACRONYMS

AAAM	Advanced Antiair Missile
AAW	Antiair Warfare
ADI	Air Defense Initiative
ADMRALS	Attack and Defense of Maritime Resources in Adverse Locales Simulator
APL	Applied Physics Laboratory
ASUW	Antisurface Warfare
ASW	Antisubmarine Warfare
BBBG	Battleship Battle Group
BFC^2	Battle Force Command and Control
BG	Battle Group
CALO	Contingency and Limited Operations
CONOPS	Concept of Operations
CVBF	Carrier Battle Force
EW	Electronic Warfare
FRAM	Fleet Requirements Analysis Model
FSE	Force Systems Engineering
IAB	Inner Air Battle
MMDA	Multiple-Measure Decision Analysis
MIW	Mine Warfare
MSC	Mission Success Criteria
NADC	Naval Air Development Center
NAVSWC	Naval Surface Warfare Center
NOSC	Naval Ocean Systems Center
NUSC	Naval Underwater Systems Center
NWC	Naval Weapons Center
NWPac	Northwest Pacific
OAB	Outer Air Battle
OPNAV	Chief of Naval Operations
PPCC	Power Projection Current Capabilities
PTA	Principal Technical Agent
R&D	Research and Development

SAIC . . . . . Science Applications International Center
SBIR . . . . . Small Business Innovative Research
SCCS . . . . . Source Code Control System
SECNAV . . . . . Secretary of the Navy
SEW . . . . . Space and Electronic Warfare
SPAWAR . . . . . Space and Naval Warfare Systems Command
STW . . . . . Strike Warfare

THEAM. . . . . Tomahawk and Harpoon Engagement Analysis Model
TLWR. . . . . Top Level Warfare Requirements

WMA . . . . . Warfare Mission Area
WSA&E . . . . . Warfare System Architecture and Engineering

INTRODUCTION

PROGRAM OVERVIEW

As part of streamlining the naval material establishment, the Space and Naval Warfare Systems Command (SPAWAR) was established in 1985 by the Secretary of the Navy (SECNAV). Within SPAWAR, SECNAV identified the need to have a warfare system architect and engineer. Major objectives of the overall WSA&E program are to (1) conduct force system engineering (architecture), (2) translate requirements into system specifications, and (3) provide system engineering at the warfare area level.[1] The WSA&E process began by concentrating on battle force command and control (BFC^2), since BFC^2 was perceived as the area for highest return on investment. A BFC^2 concept and transition plan was developed and approved by a Chief of Naval Operations (OPNAV) executive panel in December 1986. The next phase of WSA&E (1987-1988) concentrated on engineering the major warfare areas while continuing to system engineer the BFC^2 concept. From this point, WSA&E began to develop a total force orientation by looking at the engineering and evaluation of forces as a single unit. These total force concepts helped produce, for example, a 2015 Battle Management structure and are now being used to evaluate overall naval capabilities against future threats.

In FY 90, WSA&E efforts focused on conducting the sea control global conventional scenario and initiating the contingency and limited operations (CALO I) multiwarfare performance assessments. The assessment process used the sea control and power projection top-level warfare requirement mission success criteria (TLWR MSC) as the evaluation criteria. To maintain consistency, a scenario and concept of operations (CONOPS) were developed and assessments were conducted by warfare mission area (WMA) working groups. NAVSWC led the force team in integrating the WMA assessments into a total force context. As principal technical agent (PTA) for electronic warfare (EW) and mine warfare (MIW), NAVSWC directed assessment efforts in these respective areas and participated in force integration team meetings. NAVSWC continued to provide major technical anitair warfare (AAW), antisubmarine warfare (ASW), and strike and antisurface warfare (STW/ASUW) support. NAVSWC established a total force architecture by obtaining and publishing physical architecture descriptive information. In addition, NAVSWC supported the initiation of cost and affordability analyses and cooperative engagement architecture efforts.

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[1]Other functions have been incorporated into the WSA&E organization. Examples are next generation computer resources, electromagnetic environmental effects, engineering policy and standards, and the MILSTAR and OTH-T program offices. These functions are not included in this summary report.

Further details of the work accomplished by NAVSWC in FY 90 are provided in the Program Summary section of this report.

ORGANIZATION AND STAFFING

The NAVSWC WSA&E Program Office was created to (1) provide focus and project management for all Center force engineering activities, (2) provide a Center point of contact for the SPAWAR WSA&E Directorate, and (3) coordinate NAVSWC efforts with those of other participating R&D centers. A steering group was established with senior representation from each technical department to support the WSA&E Program Office in developing Center guidance and policy for NAVSWC WSA&E efforts.

To ensure the best available expertise for the WSA&E efforts, responsibilities are assigned to the technical department that has the greatest breadth and depth of knowledge and experience in the specific area. The WSA&E Program Office is attached to the Combat Systems Department, which provides the system engineering experience and disciplines most directly related to WSA&E.

Staffing of the WSA&E program has evolved as responsibilities have been assigned and tasks defined. The level of effort has evolved as shown in Table 1. NAVSWC will continue to evaluate the staffing requirements to ensure that support is directed toward areas in which NAVSWC can provide the most valuable contribution. Table 2 provides the NAVSWC financial summary.

TABLE 1. WSA&E LEVEL OF EFFORT

NAVSWC WSA&E FUNDING PROFILE:

	FY 87	FY 88	FY 89	FY 90
OVERHEAD (WKYRS)	20	50	50	30
DIRECT ($K)	--	135	455	539
WALLOPS & WSIL	--	535	46	--
COOP ENGAGEMENT				225

TABLE 2. FINANCIAL SUMMARY

DIRECT FUNDING

TASK AREA	FUNDS RECEIVED $K	FUNDS EXPENDED $K
EW	50.0	50.0
MIW TLWR	50.0	49.9
MIW ARCH	88.0	88.0
MIW APPRAISAL	18.0	17.9
AAW	108.0	107.9
ASUW	25.0	24.9
ARCH INTEGRATION	200.0	200.0
COOP ENGAGEMENT	225.0	225.0
TOTALS	**764.0**	**763.3**

INDIRECT FUNDING

TASK AREA	WORKYEARS PLANNED	WORKYEARS EXPENDED
EW	4.5	3.7
MIW	2.0	2.1
FORCE	8.0	8.1
AAW	4.0	3.9
ASW	2.0	2.3
STW/ASUW	1.5	2.1
ARCH INTEGRATION	3.0	2.5
ADMRALS	5.0	5.3
TOTALS	**30.0**	**30.0**

PROGRAM SUMMARY

The contributions made by NAVSWC during FY 90 to the WSA&E program are provided by major task category. A list of documents developed, deliverables, and products is provided for each task category.

ARCHITECTURE INTEGRATION

NAVSWC led the development of a single force physical architecture by integrating the warfare area physical architectures into a single force architecture. This physical architecture package include the following reports:

- WSA&E Platforms and Systems for Physical Architecture
- WSA&E Superset Systems for Sea Control
- WSA&E Superset Systems for CALO I
- WSA&E Platform and System Descriptions

NAVSWC also participated in requirement definitions, program reviews, and demonstrations of the SPAWAR database and integrated assessment environment Small Business Innovative Research (SBIR) efforts.

Deliverables and Actions

- Delivered miscellaneous publication NAVSWC MP 90-312, "Sea Control Force Assessment: Global Conventional War in Northwest Pacific."
- Delivered miscellaneous publication NAVSWC MP 90-159, "Physical Architecture Descriptions: System and Platform."
- Provided input for integrating various efforts into SPAWAR database team.
    - initiated effort to ensure compatibility between WSA&E ASW system descriptions and the Naval Underwater System Center's (NUSC's) "ASW Test Bed Baseline Database" system descriptions.
    - initiated efforts to ensure WSA&E platform diagrams and system descriptions consistent with the Force Systems Engineering Plan.
- Developed a list of sea control systems to be used in the total assessment and presented to the PTA working group, and developed an interconnectivity diagram for the sea control and CALO I architectures.

- Initiated efforts to generate the physical architecture information, both descriptions and drawings, using a desktop computer. The objective of the effort was to develop a software package providing the following:

    - entire or partial list of systems, user defined
    - list of systems relative to a platform or WMA
    - detailed system description
    - interconnectivity diagrams of the platforms
    - ability to interact with the proposed SPAWAR 3011 database being developed

FORCE MULTIWARFARE INTEGRATION

Force assessment efforts concentrated on the sea control global conventional and CALO scenarios. Assessment of a "Current Plus" (2000 timeframe) force warfighting capability against a 2010 threat was conducted. TLWR MSC served as evaluation criteria and as framework for assessment piece selection within the assessment efforts. NAVSWC provided support to the OPNAV TLWR developers to attempt to ensure information contained within the TLWR was sufficient for evaluation from a WSA&E perspective.

With the assessment framework established in FY 89, the individual WMA working groups assessed their portions of the architecture using analysis methodologies previously established. A common framework was established within which the WMA working groups could assess their portion of the force architecture. Members of the force integration team participated in each of the WMA working group assessment meetings to observe the process from the force perspective and to assist in coordinating the efforts between the WMAs. Based on force integration discussions regarding the sea control and CALO I assessments, several areas of sensitivity were identified. The assessment framework was modified as required, and the assessment and integration efforts of these sensitivity studies were conducted.

As technical lead for the multiwarfare assessment, NAVSWC hosted multiwarfare assessment meetings, prepared final briefings following each force meeting, and developed reports and briefing packages for the multiwarfare assessment effort. In anticipation of FY 91 efforts, NAVSWC supported the development of plans to compile sensitivities and shortfalls from all previous assessment efforts to provide input to the OPNAV Summary Warfare Appraisal.

Deliverables and Actions

- Delivered carrier battle force (CVBF) force assessment as miscellaneous publication NAVSWC MP 90-159, "Physical Architecture Descriptions: System and Platform."

- Conducted a review of the sea control TLWR and provided comments to SPAWAR 30 and OP-701.

- Conducted Force Break Seminar meetings to ensure a consistent framework in developing CONOPS, identifying TLWR MSCs for use in assessments, identifying assessment pieces, and performing assessments.

- Maintained a force central operation to allow for required information exchanges between WMA assessment working groups and identify issues between warfare areas that arose during assessments.

- Developed and provided to SPAWAR 30 minutes on Force Break Seminar and program design review meetings.

- Participated in efforts to establish an Attack and Defense of Maritime Resources in Adverse Locales Simulator (ADMRALS) site at NAVSWC White Oak for use in future force analysis efforts.

- Supported incorporation of the sea control global conventional scenario into ADMRALS for proof of concept efforts.

- Supported SPAWAR 301 in the development of the multiwarfare scoping tool by conducting evaluations of this tool during its development.

ELECTRONIC WARFARE (EW)

As EW PTA, NAVSWC led the development of EW CONOPS for both the sea control global conventional warfare and CALO assessments. In addition, NAVSWC assigned EW working group representatives to participate in each WMA working group assessment in support of the integrated multiwarfare force assessment. In conjunction with these representatives, the working groups integrated each EW WMA assessment into an EW assessment from a force perspective. This process of integrating the EW portions facilitated the integration of the WMA results into the total force package during the force integration team meetings. NAVSWC was an active participant in all architecture executive board meetings and led the effort to identify and complete the required EW sensitivity studies.

NAVSWC supported the OP-76 POM-94 EW appraisal by developing and assessing an EW functional architecture. This effort evaluated, qualitatively, a set of systems against key EW functions. A relational database was then developed that contained functions, system and functional relationships, system and WMA relationships, and a ranking of system importance and capability.

In support of WSA&E efforts to develop a force analysis environment, NAVSWC led an SBIR Phase I effort to develop concepts for incorporating EW analyses. This

work was continued in initiating an SBIR Phase II effort to develop EW algorithms for implementation into the ADMRALS environment.

Deliverables and Actions

- Developed an EW functional architecture circa 2000 in support of the OP-76 EW POM appraisal.
- Conducted assessment of the functional architecture for the year 2000 in support of OP-76 FY 94 POM EW appraisal.
- Conducted EW working group meetings and as EW PTA, participated in force scenario, CONOPS, and PTA meetings.
- Supported SPAWAR 314 advanced tactical support study by developing the EW variant requirements.
- Conducted analysis of ESM (ES-3A, EP-3 and E-2C), EA-6B support jamming, and A-6 self-protection for war-at-sea ASUW assessment.
- Conducted analysis of counter-targeting plan and ship self-protection capability for a new missile threat in support of AAW assessment.
- Supported AAW CALO I assessment with an electronic surveillance measures in raid count/intentions with ES-3/EP-3 parametric study, a ship self-defense parametric study on SLQ-32 antiship missile defense performance, and surface-subsurface coordinator assessment.
- Developed and provided to the physical architecture team EW physical architecture descriptions.
- Lead SBIR Phase I effort to develop concept to incorporate EW analysis into force analysis environment. Evaluated Phase II SBIR proposal for the development of a method to develop EW algorithm and approved to incorporate into the ADMRALS environment.

MINE WARFARE (MIW)

As MIW PTA, NAVSWC provided MIW architecture system descriptions to the architecture and engineering team for incorporation into the integrated force architecture. In support of the integrated force assessment process, NAVSWC participated in meetings to define the scenario and establish the CONOPS and provided input to the ASW plans for laying mine fields. Assessment of mine field capabilities were provided as required.

Deliverables and Actions

- As MIW PTA, conducted regular MIW working group meetings with the MIW architecture team and participated in force scenario, CONOPS, and PTA meetings.
- Developed and provided MIW system descriptions to the physical architecture team.
- Developed an MIW architecture for the 2000 timeframe.
- Completed the assessment of the Northwest Pacific (NWPac) pieces, egress mining and CVBF-B haven mining. A set of annotated viewgraphs was produced and the presentation was given at the force assessment meeting.
- Conducted and integrated assessment of ASW and MIW for CVBF in the sea control assessment effort.
- Coordinated with the ASW working group to investigate utility of mining operations in support of ASW.
- Completed assessment of CALO I pieces in support of an amphibious objective area, haven mining, killing fields, and mining in a sea line of communication. A set of annotated viewgraphs was developed and presented at the force assessment meeting.
- Developed a white paper on the water depth coverage gap between existing bottom and moored mines. This paper served as the basis for the SUBSTRIKE operation requirement.
- Developed and demonstrated the design of a user interactive program for evaluating MIW or mine countermeasures systems or concepts from a military effectiveness and cost-and-risk basis. Cost-and-risk scores were assigned by expert opinion to each system or concept considered in an architecture assessment. The highest scores were assigned for those capabilities with the lowest cost and lowest risk.

ANTIAIR WARFARE (AAW)

Major support was provided during the integrated force assessment. This support included leading analysis efforts of the inner air battle (IAB) and assisting in documentation of the AAW CONOPS and assessment results for the sea control global conventional war and CALO scenarios. NAVSWC also reviewed the AAW portions of the CVBF physical architecture and provided additions and corrections as required.

NAVSWC led the IAB efforts for the AAW working group. NAVSWC produced reports describing the architecture sensitivities and assessments for SPAWAR 314 to

review and assisted in the development of a presentation on the AAW sensitivity studies and assessments for delivery to SPAWAR 31. NAVSWC provided input to the IAB for high-intensity and CALO system analysis and tradeoff studies in support of the OP-75 critical system ranking task.

NAVSWC supported model and force analysis environment development efforts with respect to AAW by providing inputs to the Applied Physics Laboratory (APL) for the AAW scoping model, SHAM.

Deliverables and Actions

- Delivered miscellaneous publication NAVSWC MP 89-145, "Architecture Options for CVBF in Conduct of AAW," Vol. 3.

- Delivered technical report NAVSWC TR 90-130, "Shipboard Hardkill AAW Self-Defense Systems."

- Delivered technical report NAVSWC TR 90-132, "2010 Soviet Threat to Battle Force Combatant."

- Delivered technical report NAVSWC TR 90-274, "2010 Northwest Pacific Scenario AAW Inner Air Battle Analysis."

- Delivered technical report NAVSWC TR 90-276, "2010 Middle East Scenario AAW Inner Air Battle Analysis."

- Led the IAB analysis in support of the OP-75 POM appraisal, designated critical systems, ranking for both high-intensity conflict and CALO scenarios. NAVSWC developed detailed reports on the input data used in the analysis, targeting, and hits-on-ships results. Results were given for cases with and without cooperative engagement and with the current and future self-defense surface missile system.

In support of the AAW force assessment, NAVSWC:

- Conducted IAB analysis in support of force sea control and CALO assessments. Analysis was conducted independent of OAB results, and results were then fully integrated with OAB analytical results. Developed AAW physical architecture descriptions and reviewed force architecture for AAW consistency. Conducted analysis of the sea control designated critical systems in the CVBF AAW scenario. Developed the scenario to include threat launch times and positions. Worked with EW architecture group to define the appropriate force response in EW. Worked with the Naval Tactical Intelligence Center to define threat parameters for analytical inputs. Input data used in the analysis were reported, targeting was provided, and hits-on-ships results were summarized. Results were given for both cases for both good and bad weather.

- Provided assessment of AAW effectiveness in support of MIW architecture assessment of CVBF haven.

- Delivered annotated viewgraphs of the analyses conducted in support of the sea control IAB phases for scenario pieces (CVBG A, Repeated Attacks Assessment, and Bowers Basin (CVBF B) Assessment) and CALO (NEO, CVBG-B, BBBG and surface action group, and AOA) tasks.

- Provided inputs to physical architecture for CALO scenario for surface ship combat system definitions.

- Provided inputs to APL for the exercise of the scoping model, SHAM, based on the AAW results of the IAB matched to the OAB results from NADC. A multiattack scenario was run on fleet requirements analysis model (FRAM), and the results were used as the final AAW outputs for the sea control assessment.

- Used the Oracle database software to analyze event files extracted from FRAM computer simulation runs. This capability automatically provided a variety of detailed results from the simulation runs, including graphic plots of the results.

- Upgraded the FRAM algorithm for determining the conditions under which AEGIS ships launch a dual-missile salvo.

- Upgraded SPY-1 model used in FRAM to better account for ECCM capabilities. Modeling change was required to accommodate threat ECM techniques not previously modeled.

STRIKE AND ANTISURFACE WARFARE (STW/ASUW)

NAVSWC provided major technical support to the STW/ASUW working group. In support of the multiwarfare assessment, NAVSWC reviewed the CVBF TLWR to identify STW/ASUW requirements and provided inputs on planned Tomahawk capabilities for the 2003 timeframe. NAVSWC led the analysis of Tomahawk and Harpoon for the war-at-sea assessment piece of the scenario. NAVSWC assumed the responsibility for developing battleship battle group (BBBG) CONOPS for amphibious assault fire support operations and defense against missile/torpedo boat attack for CALO I assessment. In addition, BBBG surface gunfire and surface-launched cruise missile effectiveness assessments were conducted.

Deliverables and Actions

- Participated in both the sea control and power projection current capabilities (PPCC) subgroups. Provided inputs to these subgroups.

- Reviewed STW/ASUW CONOPS for the sea control and CALO I assessments from a surface warfare perspective.

- Prepared draft sections of the PPCC architecture description document (Missiles and Roles and Sequence of Operations). Developed draft concept for a future massed power projection force architecture, incorporated in one of two of the final surface intensive force options.

- Conducted assessment of attack results for sea control global conventional scenario using the THEAM cruise missile engagement model. Delivered preliminary attack results for air-launched Harpoon attacks.

- Provided final THEAM results to the STW/ASUW working group for air-launched Harpoon. These results were coordinated with the STW/ASUW tactical operations model runs to assess battle force ASUW effectiveness against hostile surface force in the NWPac scenario.

- Developed and presented a massed option to the STW/ASUW working group. Four options were reduced to two alternatives: (1) a "sudden" option stressing surface assault and fire support, and (2) a "sequential" option stressing air assault and fire support.

- Developed draft papers for the STW/ASUW working group on the BBBG CONOPS for the CALO I, which included the BBBG advance operation and amphibious assault fire support operation, and on the ASUW assessment situation with the BBBG defending against a missile and torpedo boat attack.

- Developed and provided to the STW/ASUW working group a BBBG CONOPS for transit, shore bombardment, and fire support of the amphibious assault operation.

- Conducted assessment of BBBG surface gunfire and surface-launched missile effectiveness against surface and land targets in the CALO I scenario.

- Conduted lethality assessments for 16-in. gunfire effectiveness against 10 representative land targets for several sets of accuracy parameters.

- Completed a final draft of the BBBG patrol boat engagement situation for CALO I. A BBBG land target list was also finalized and provided to the Naval Weapons Center (NWC) and NUSC. This list, derived from the BBBG CONOPS and additional data from intelligence documents, provided the basis for the BBBG land strike and surface fire support assessments.

- Conducted assessment of surface ship performance in defense against patrol boat attacks and BBBG performance in shore bombardment and fire support for the amphibious assault operation. Results were provided to the AAW working group to assess the missile attack from surviving missile boats.

ANTISUBMARINE WARFARE (ASW)

NAVSWC supported ASW sea control analysis efforts by assessing ASW screen and mine field effectiveness. In addition, NAVSWC conducted air defense initiative (ADI)/area ASW risk assessments and initiated ASW model comparison efforts.

Deliverables and Actions

- Formulated an ASW structured analysis methodology.
- Initiated efforts to compare McDonnell Douglas SCAT model with APSURF ASW model.
- Developed an ADI assessment model, which combined system performance and cost and technical risk with the Naval Ocean Systems Center (NOSC), NUSC, MITRE and Science Applications International Corporation (SAIC). Formulated an assessment methodology that could be used to evaluate different ADI architecture options for the ADI investment working group.
- Conducted and completed a Phase I risk assessment for area ASW. This risk assessment was conducted on the systems in the 2000 area ASW architecture. This information was provided to the ASW analysis working group.
- Developed (with NOSC, NUSC, and MITRE) an evaluation model that combined system performance, cost, and technical risk to assess overall ADI system options.
- Developed Phase II ADI/area ASW risk assessment method. Used the Delphi technique to evaluate the technical risk, military worth, and programmatic risk for the current and future ADI/area systems. Preliminary results were sent to MITRE as input to the ADI assessment model. A draft report was sent to NUSC to be incorporated into the ADI investment report.
- Conducted an analysis and delivered results in support of the sea control force assessment including the following:
    - computed ASW screen effectiveness against a threat submarine using the APSURF engagement model
    - computed combined ASW screen and mine field effectiveness to determine probability of threat submarine reaching torpedo launch range
    - calculated probability of torpedo hits based on existing surface ship torpedo defense effectiveness data.
- Developed integrated AAW, ASW, and MIW assessment to determine effectiveness of threat destroying high value units.

ATTACK AND DEFENSE OF MARITIME RESOURCES IN ADVERSE LOCALES SIMULATOR (ADMRALS)

ADMRALS is a NAVSWC initiative to use distributed processing and parallel computing techniques to develop a force analysis modeling environment that allows integration of various models or algorithms into a common simulation environment. A team of technology and analyst personnel was established in FY 90 to begin to evaluate the utility of the ADMRALS environment with analytical personnel. ADMRALS efforts included the following:

- Upgrading the ADMRALS network control software
- Conducting benchmark studies related to the SPAWAR 30 Sea Control assessment
- Developing a new threat generator
- Establishing an ADMRALS environment at the NAVSWC/White Oak facility for use by personnel conducting analysis for the WSA&E program.

Deliverables and Actions

- Delivered technical report NAVSWC TR 90-169, " Neural Networks Implementation of F14 Battle Management Fusion Algorithm Rule Base."

Environment Improvements.

- Integrated a sub-on-sub model developed by the Center for Naval Analyses into the ADMRALS environment, and developed supporting software such that sub-on-sub engagements would be completely reactive and two-sided.
- Modified software to support the sea control scenario based on discussions with the Naval Air Development Center (NADC), the Combat Systems Engineering and Assessment Division, and the AEGIS Program Office. The modifications involved adding infrared search and track to fighters, modifying combat air patrol stations, improving fighter-on-fighter engagement algorithms, adding Red bomber-on-Blue fighter engagements, modifying carrier flight operations, and modifying fighter sponges. Other software modifications included improving E-2 and Blue fighter radar algorithms, developing a Blue advanced air-to-air missile (AAAM) model, improving antiair warfare commander model, and improving the sponge models in the outer air battle (OAB).
- Developed and tested a stand-alone semi-intelligent threat generator that allows higher fidelity representations of Red attack profiles. The threat generator develops threats independent of Blue defense models and facilitates threat type/class

changes within ADMRALS and to accommodate variable launch ripple rates. Threat maneuvers can be prescribed by users. Documentation for the threat generator is in preparation.

- Enhanced graphics capabilities to include land masses, coastlines, and range and bearing grids to plot Blue AAAM trajectories and to support SUN workstations.

- Initiated development of front-end, menu-driven databases to support platform architecture definition, scenario definition, execution, and postprocessing.

- Developed and began testing of baseline software prototype for dynamic allocation of network resources.

- Developed baseline network controller to check system mode availability and determine which processor is minimally loaded.

- Designed a prototype configuration management system. Developed templates for software documentation. Initiated development of documentation and users' guides and development of user-friendly interfaces.

- Secured the facility and obtained automated data processing approval to run classified scenarios. Standard operating procedures for classified runs were written and approved. The network was accredited secret.

- Transferred the FRAM simulation model from the Cyber mainframe to SUN equipment purchased for the ADMRALS environment, Monte Carlo runs were made with 4 to 10 times the number of iterations usually provided. This change resulted in decreased running costs and improved turn-around time.

Proof of Concept.

- Successfully ran one iteration of the sea control scenario integrating the conventional multiship FRAM, OAB, and ASW models. Database analysis was performed, and the results (although only one interation) presented were similar to results obtained by the AAW working group.

- Installed the baseline ADMRALS system consisting of the network communication control package, the network time control package, the stand-alone threat generator package, and the IAB model on the NAVSWC network at White Oak to allow analysts to use the ADMRALS environment.

COOPERATIVE ENGAGEMENT

NAVSWC participated in a Navy Cooperative Engagement Architecture group chaired by SPAWAR 31. The purpose of the working group was to develop an architectural framework for the Navy's battle groups that would use "cooperating engagement" techniques in all warfare areas.

Architecture Assessment Methodology Development.

- Participated with SPAWAR, David Taylor Research Center, and NOSC to develop a cooperative engagement architecture assessment methodology. The group developed a hierarchial framework of battle group system measures that could be used to identify battle force asset characteristics. These measures could be used to compare the value of alternative implementation paths of a cooperative battle group (BG) architecture by using multiple-measure decision analysis (MMDA) techniques. The group succeeded in building the measure of effectiveness hierarchy and in applying the MMDA for an example architecture. The findings of the group were presented to the larger working group over the course of the Phase I study.

Specific Operation Concepts Support.

- Developed specific cooperative engagement CONOPS. These concepts listed ways in which cooperating BG units could achieve higher threat kills over non-cooperating units. The concepts were devised to support an implementation path developed by the larger working group. In addition, specific examples of EW and signature management tactics were included in the concepts to show their advantages in supporting cooperative threat engagement. A brief representing these CONOPS was developed and presented.

SPACE AND ELECTRONIC WARFARE (SEW)

- NAVSWC initiated support to SPAWAR 30T in the development of an SEW architecture. Inputs were provided to this architecture team from an EW perspective. The EW functional architecture was used as the basis for this effort.

COST AND AFFORDABILITY

NAVSWC supported the development of a cost panel and provided input to the development of detailed plans and budgets for five cost and affordability analysis tasks to begin in FY 91. These tasks were initiated to support development of fiscal assessments and investment strategies for future Navy architectures. The tasks include the following:

- Developing a system dynamics model of top-level Navy budgets

- Defining requirements and context for future force
- Developing a total Navy force scoping model
- Developing a Navy force cost model
- Providing a cost estimation for fiscally constrained architectures

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